US009258483B2

(12) **United States Patent**
Ju et al.

(10) **Patent No.: US 9,258,483 B2**
(45) **Date of Patent: *Feb. 9, 2016**

(54) **MULTI-PURPOSE CAMERA SYSTEM SUPPORTING NORMAL CAMERA FUNCTIONALITY AND ADDITIONAL USER INPUT FUNCTIONALITY**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 579 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/485,936**

(22) Filed: **Jun. 1, 2012**

(65) **Prior Publication Data**

US 2013/0324190 A1 Dec. 5, 2013

(51) **Int. Cl.**

H04M 1/00	(2006.01)
H04N 5/228	(2006.01)
H04N 5/232	(2006.01)
G06F 3/03	(2006.01)
G06F 3/0354	(2013.01)

(52) **U.S. Cl.**

CPC ***H04N 5/23245*** (2013.01); ***G06F 3/0317*** (2013.01); ***G06F 3/03547*** (2013.01)

(58) **Field of Classification Search**

CPC .. H04W 88/02; H04N 5/23245; H04N 5/228; H04N 9/73; H04N 5/23248; H04N 5/225; G06F 3/03547; G06F 3/0317; G06F 3/041; G06F 3/033

USPC 455/556.1, 66.1, 67.11, 557, 556.2, 455/566; 348/222.1, 223.1, 208.4, E05.031, 348/E09.051, 208.1

See application file for complete search history.

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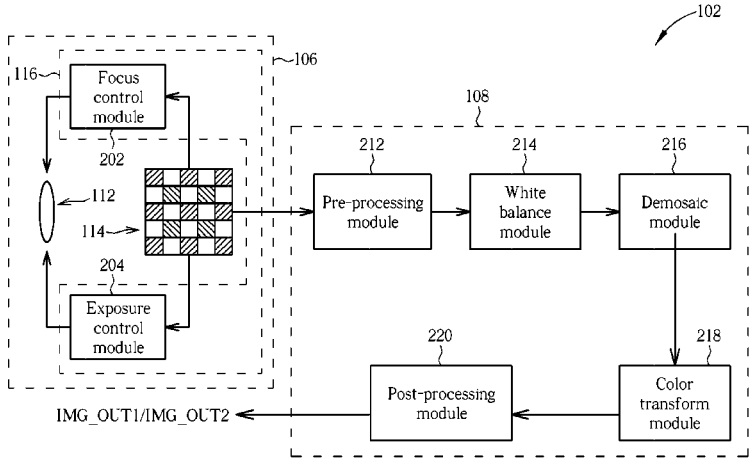
(57) **ABSTRACT**

A multi-purpose camera system includes an image capture block and an image signal processing block. The image capture block is arranged for generating an image signal, wherein the image capture block has an image sensor, an optical system, and a control circuit. The image signal processing block is arranged for processing the image signal. When the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input; and an overall configuration of the control circuit and the image signal processing block in the first operation mode is different from an overall configuration of the control circuit and the image signal processing block in the second operation mode.

25 Claims, 5 Drawing Sheets



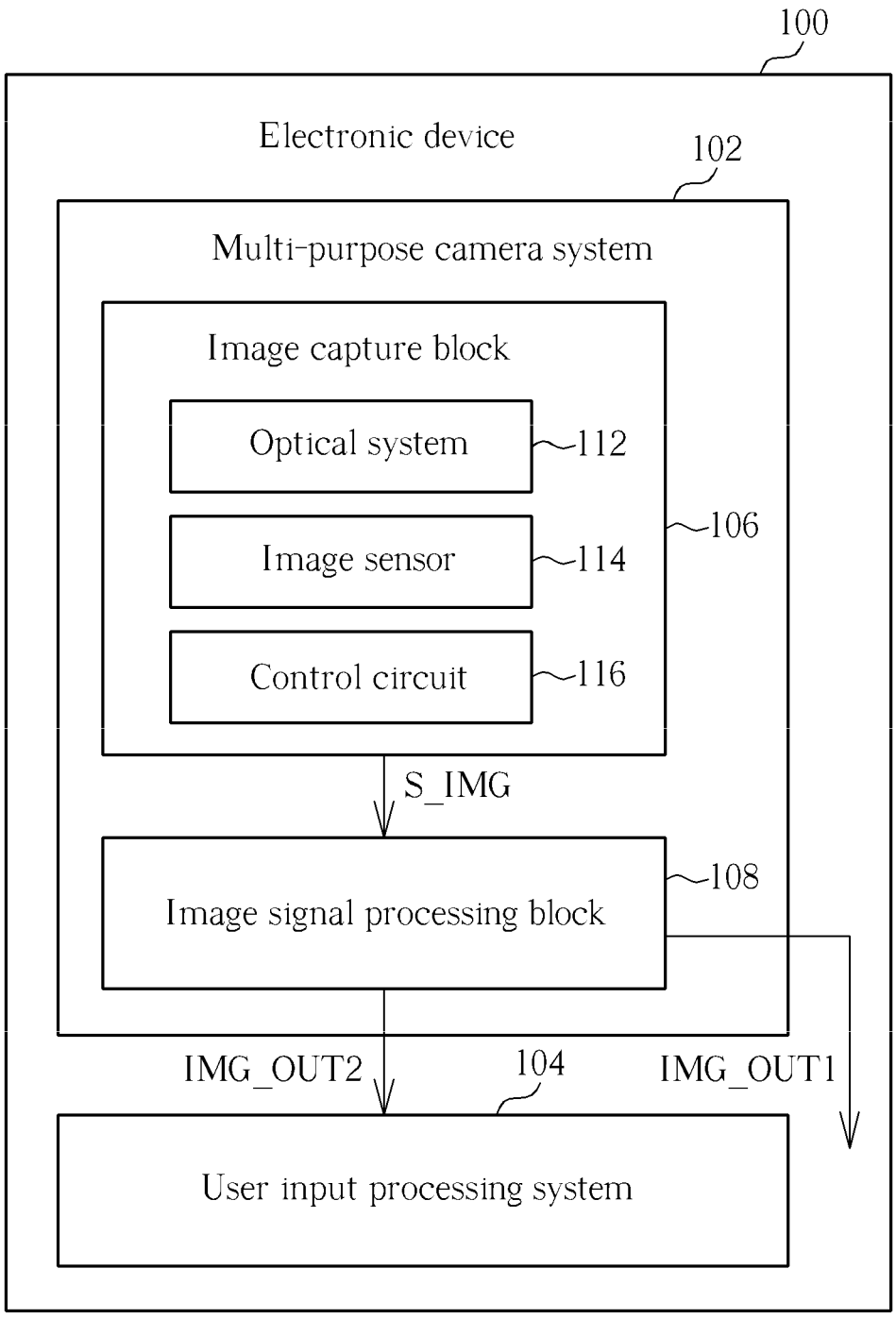

100
Electronic device
102
Multi-purpose camera system
Image capture block
Optical system
112
Image sensor
114
Control circuit
116
106
S_IMG
Image signal processing block
108
IMG_OUT2
104
IMG_OUT1
User input processing system

FIG. 1

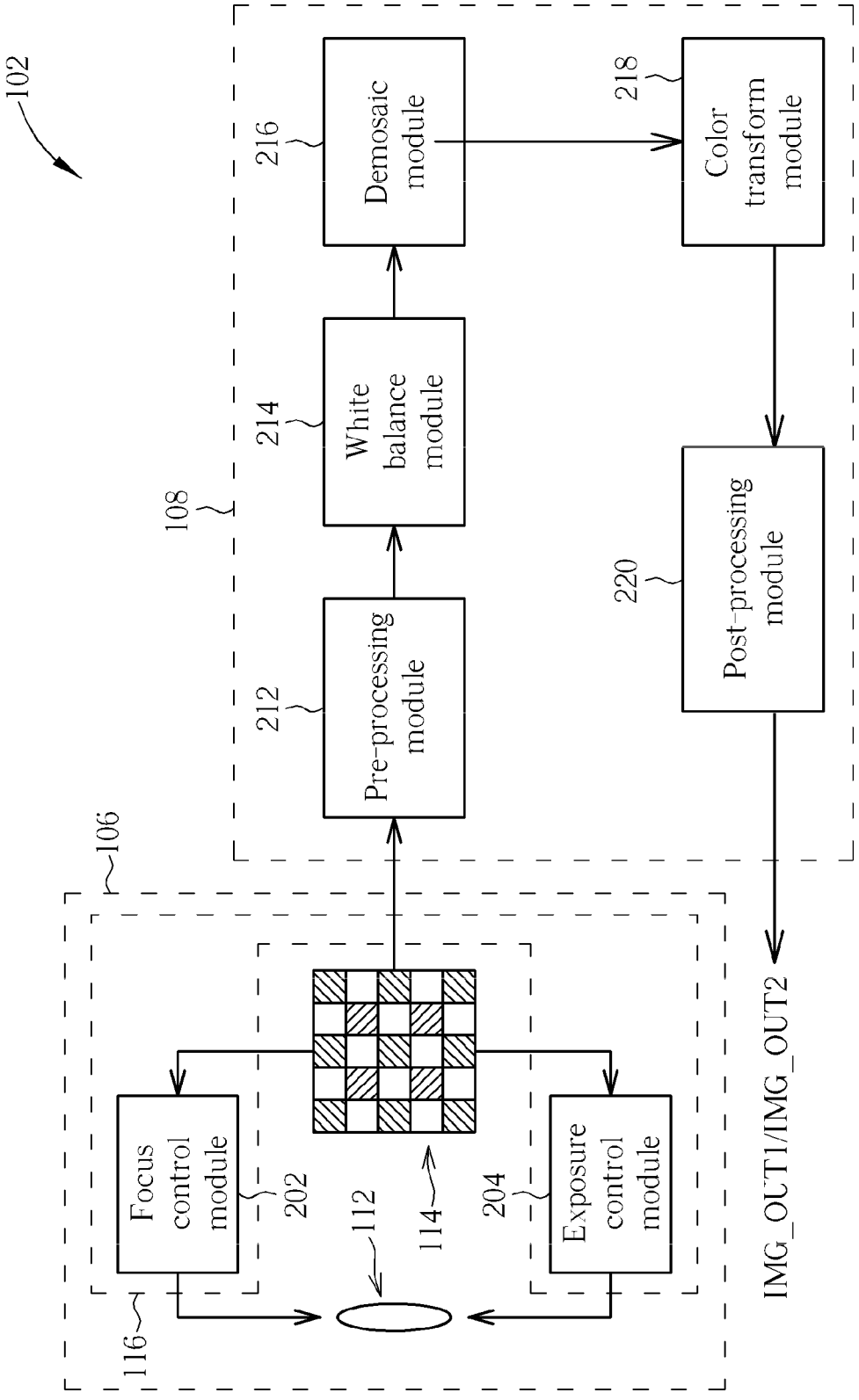

102
106
108
112
114
116
202
204
212
214
216
218
220
Focus control module
Exposure control module
Pre-processing module
White balance module
Demosaic module
Color transform module
Post-processing module
IMG_OUT1/IMG_OUT2

FIG. 2

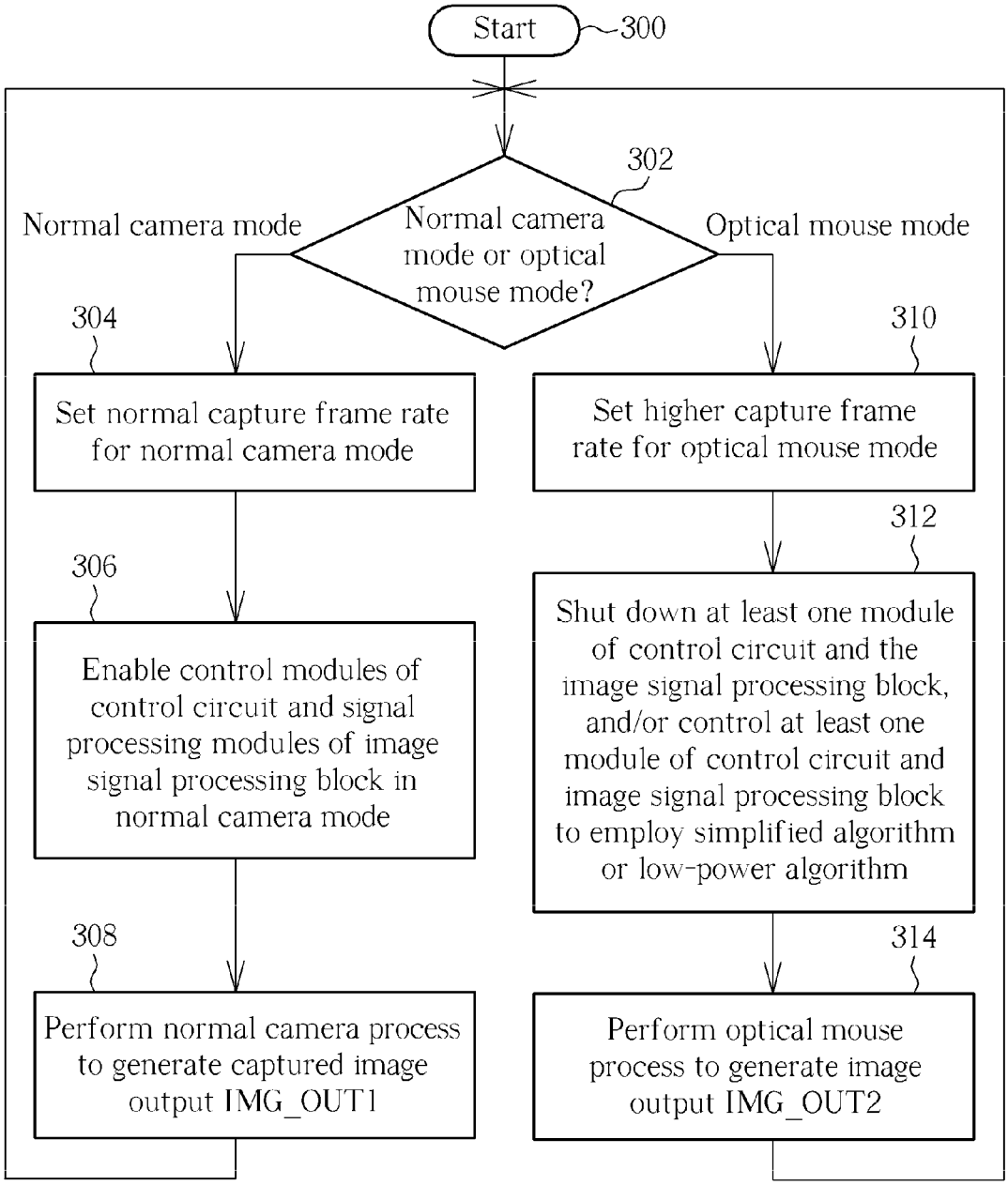

Start
300
302
Normal camera mode or optical mouse mode?
Normal camera mode
Optical mouse mode
304
Set normal capture frame rate for normal camera mode
306
Enable control modules of control circuit and signal processing modules of image signal processing block in normal camera mode
308
Perform normal camera process to generate captured image output IMG_OUT1
310
Set higher capture frame rate for optical mouse mode
312
Shut down at least one module of control circuit and the image signal processing block, and/or control at least one module of control circuit and image signal processing block to employ simplified algorithm or low-power algorithm
314
Perform optical mouse process to generate image output IMG_OUT2

FIG. 3

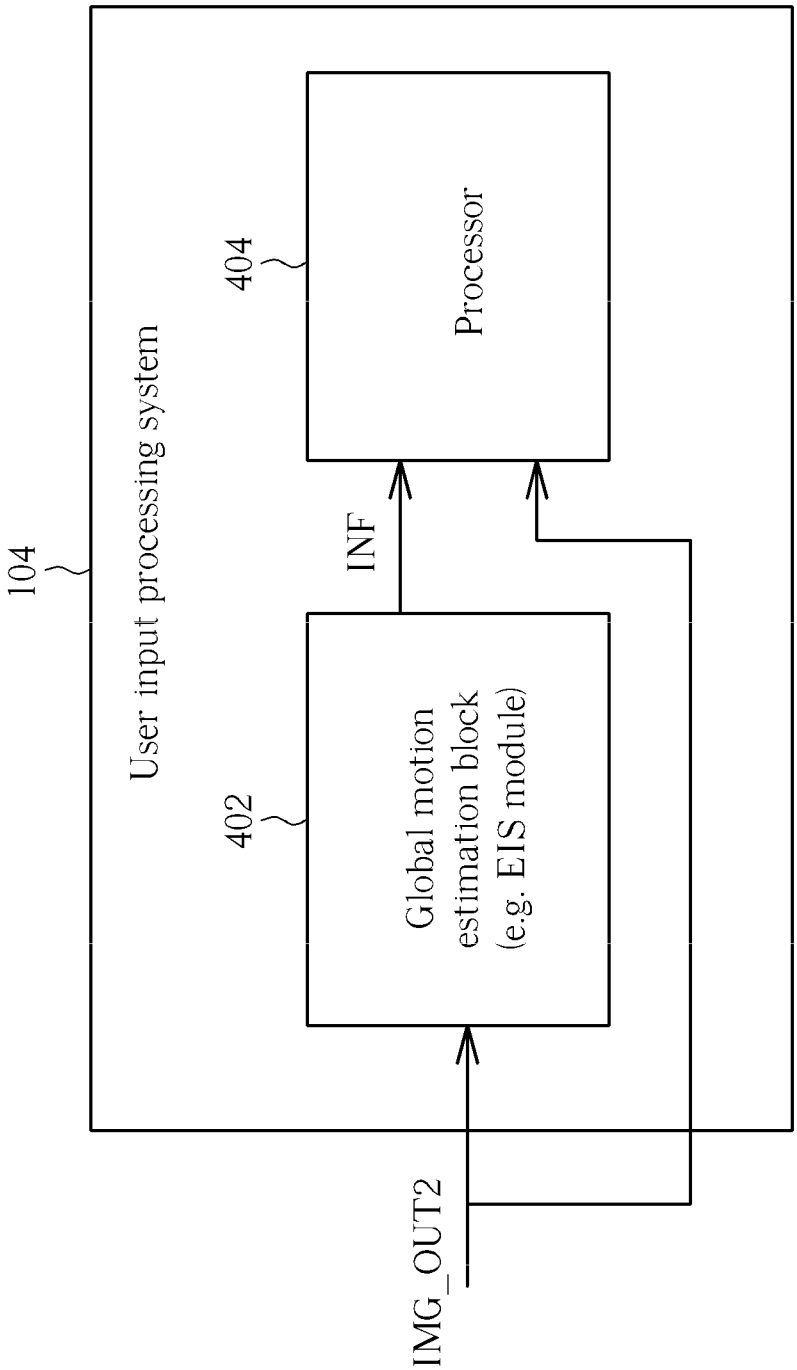

104
User input processing system
402
Global motion estimation block (e.g. EIS module)
INF
404
Processor
IMG_OUT2

FIG. 4

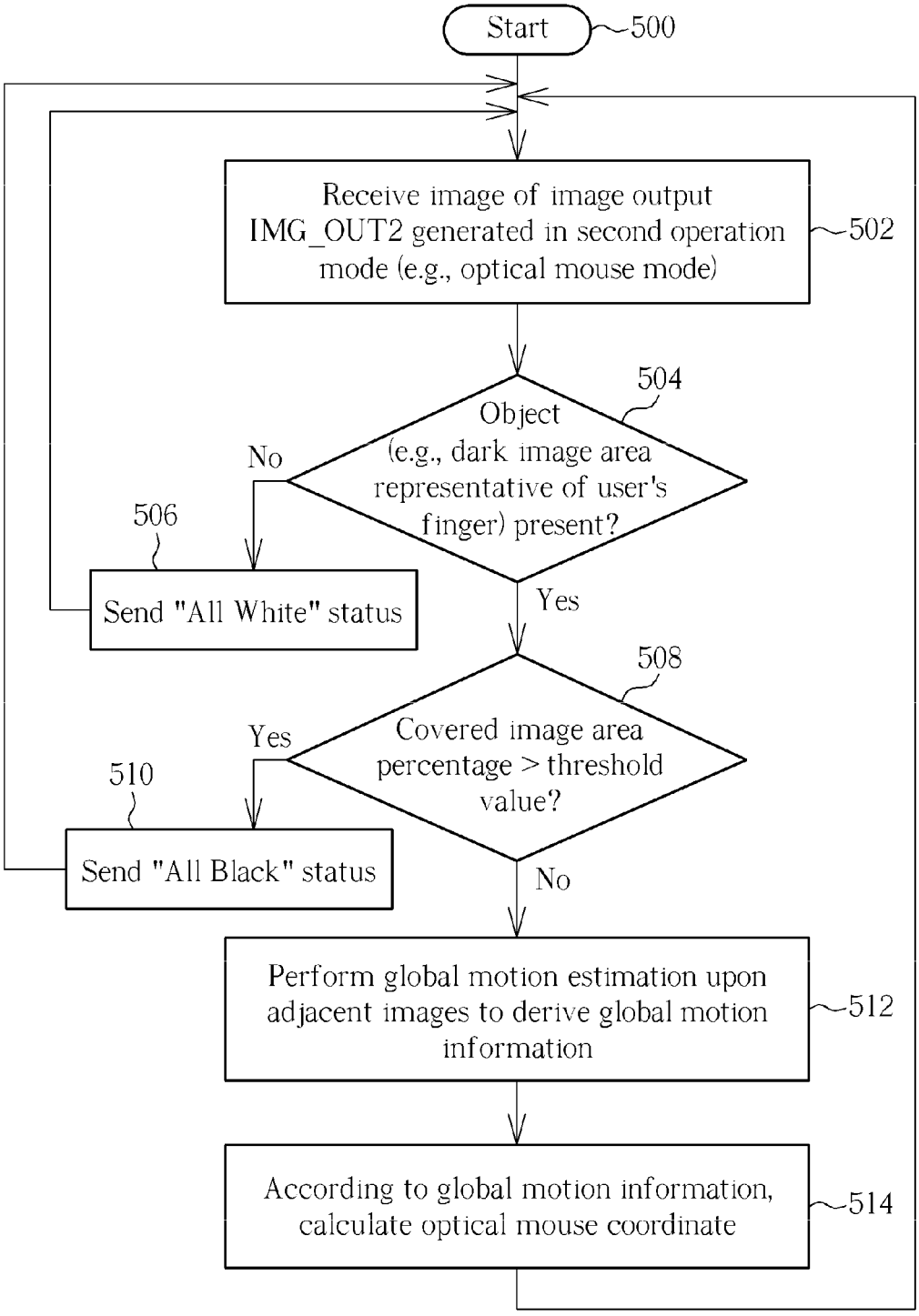

Start
500
Receive image of image output IMG_OUT2 generated in second operation mode (e.g., optical mouse mode)
502
504
Object (e.g., dark image area representative of user's finger) present?
No
Yes
506
Send "All White" status
508
Covered image area percentage > threshold value?
Yes
No
510
Send "All Black" status
Perform global motion estimation upon adjacent images to derive global motion information
512
According to global motion information, calculate optical mouse coordinate
514

FIG. 5

MULTI-PURPOSE CAMERA SYSTEM SUPPORTING NORMAL CAMERA FUNCTIONALITY AND ADDITIONAL USER INPUT FUNCTIONALITY

BACKGROUND

The disclosed embodiments of the present invention relate to a camera system, and more particularly, to a multi-purpose camera system which supports normal camera functionality and additional user input functionality.

A traditional feature phone is equipped with standard directional buttons or a directional pad. In general, the standard directional button/directional pad is made by a mechanical structure. Hence, to enter the user input, the user has to press the directional button/directional pad with larger force. In addition, as the standard directional button/directional pad is implemented using the mechanical structure, it may have degraded sensitivity after being used for a long time.

Thus, there is a need for an improved user interface which can take place of the standard directional button/directional pad for cost reduction and allow the user to easily and accurately enter the user input.

SUMMARY

In accordance with exemplary embodiments of the present invention, a multi-purpose camera system which supports normal camera functionality and additional user input functionality is proposed to solve the above-mentioned problem.

According to a first aspect of the present invention, an exemplary multi-purpose camera system is disclosed. The exemplary multi-purpose camera system includes an image capture block and an image signal processing block. The image capture block is arranged for generating an image signal, wherein the image capture block has an image sensor, an optical system, and a control circuit. The image signal processing block is arranged for processing the image signal. When the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input; and an overall configuration of the control circuit and the image signal processing block in the first operation mode is different from an overall configuration of the control circuit and the image signal processing block in the second operation mode.

According to a second aspect of the present invention, an exemplary electronic device is disclosed. The exemplary electronic device includes a multi-purpose camera system and a user input processing system. The multi-purpose camera system includes an image capture block and an image signal processing block. The image capture block is arranged for generating an image signal, wherein the image capture block comprises an image sensor, an optical system, and a control circuit. The image signal processing block is arranged for processing the image signal, wherein when the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input; and an overall configuration of the control circuit and the image signal processing block in the first operation mode is different from an overall configuration of the control circuit and the image signal processing block in the second operation mode. The user input processing system is for acting as another part of the user input apparatus, and is arranged for identifying the user input by processing an image output of the image signal processing block in the second operation mode.

According to a third aspect of the present invention, an exemplary multi-purpose camera system integrated in a portable electronic device is disclosed. The exemplary multi-purpose camera system includes an image capture block and an image signal processing block. The image capture block is arranged for generating an image signal. The image signal processing block is arranged for processing the image signal. When the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; and when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating an electronic device according to an exemplary embodiment of the present invention.

FIG. **2** is a diagram illustrating an exemplary implementation of the multi-purpose camera system shown in FIG. **1**.

FIG. **3** is a flowchart illustrating a mode switching operation of the multi-purpose camera system according to an exemplary embodiment.

FIG. **4** is a diagram illustrating an exemplary implementation of the user input processing system shown in FIG. **1**.

FIG. **5** is a flowchart illustrating an exemplary user input identification operation performed by the user input processing system to identify the user input as one optical mouse operation.

DETAILED DESCRIPTION

Certain terms are used throughout the description and following claims to refer to particular components. As one skilled in the art will appreciate, manufacturers may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not function. In the following description and in the claims, the terms "include" and "comprise" are used in an open-ended fashion, and thus should be interpreted to mean "include, but not limited to . . . ". Also, the term "electrically connected" is intended to mean either an indirect or direct electrical connection. Accordingly, if one device is electrically connected to another device, that connection may be through a direct electrical connection, or through an indirect electrical connection via other devices and connections.

The main concept of the present invention is to use a camera system as part of a user input apparatus. In other words, the present invention is directed to a multi-purpose camera system which supports multiple operation modes. For example, when the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a normal camera, and when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of the user input apparatus. Further details are described as below.

FIG. **1** is a block diagram illustrating an electronic device according to an exemplary embodiment of the present invention. The electronic device **100** may a portable electronic device, such as a mobile phone with the proposed multi-purpose camera system integrated therein. As shown in FIG. **1**, the electronic device **100** includes, but is not limited to, a multi-purpose camera system **102** and a user input processing system **104**. The multi-purpose camera system **102** has an image capture block **106** and an image signal processing block **108**, where the image capture block **106** has an optical system **112**, an image sensor **114**, and a control circuit **116**. The image capture block **106** is arranged for generating an image signal S_IMG, and the image signal processing block **108** is arranged for processing the image signal S_IMG to generate an image output IMG_OUT**1**/IMG_OUT**2**. When the multi-purpose camera system **102** is operated in a first operation mode (e.g., a normal camera mode), the multi-purpose camera system **102** acts as a camera for generating a captured image output IMG_OUT**1**. However, when the multi-purpose camera system **102** is operated in a second operation mode (e.g., a special camera mode such as an optical mouse mode), the multi-purpose camera system **102** acts as part of a user input apparatus for receiving a user input and correspondingly generating an image output IMG_OUT**2**. Besides, the user input processing system **104** acts as another part of the user input apparatus, and is arranged for identifying the user input by processing the image output IMG_OUT**2** of the image signal processing block **108** in the second operation mode. It should be noted that an overall configuration of the control circuit **116** and the image signal processing block **108** in the first operation mode is different from an overall configuration of the control circuit **116** and the image signal processing block **108** in the second operation mode.

Please refer to FIG. **2**, which is a diagram illustrating an exemplary implementation of the multi-purpose camera system **102** shown in FIG. **1**. As shown in FIG. **2**, the control circuit **116** in the image capture block **106** may include a focus control module **202** and an exposure control module **204**. The optical system **112** may include a lens module whose focus setting and exposure setting (e.g., aperture size and/or shutter speed) are controlled by the focus control module **202** and the exposure control module **204**, respectively. Regarding the image signal processing block **108**, it includes a plurality of signal processing modules, such as a pre-processing module **212**, a white balance module **214**, a demosaic module **216**, a color transform module **218**, and a post-processing module **220**. The pre-processing module **212** may perform dark current compensation, linearization, flare compensation, etc. The white balance module **214** may perform automatic/manual compensation for white balance by applying different weighting factors to the red (R), green (G) and blue (B) components of an image. The demosaic module **216** may make use of pixel neighborhood information to estimate values of pixel colors that are not measured/sensed by the image sensor **114**. The color transform module **218** may perform a color transform from one color space to another color space. For example, the color transform module **218** may perform an RGB-to-YUV color transform upon a color image to thereby derive a black & white image. The post-processing module **220** may perform color-artifact removal, edge enhancement, coring, etc.

By way of example, but not limitation, changing the overall configuration of the control circuit **116** and the image signal processing block **108** may be realized by disabling at least one signal processing module/control module and/or controlling at least one signal processing module/control module to employ a different algorithm (e.g., a simplified algorithm or a low-power algorithm). For clarity, assuming that the multi-purpose camera system **102** acts as part of an optical mouse when configured to operate in the second operation mode (e.g., special camera mode), several examples with reference to the exemplary multi-purpose camera system **102** shown in FIG. **2** are disclosed hereinafter.

In a first exemplary design, at least one signal processing module included in the image signal processing block **108** is enabled (or powered on) in the first operation mode, and is disabled (or powered off) in the second operation mode. As the multi-purpose camera system **102** operated in the second operation mode to perform an optical mouse function does not need to produce a precise image of a captured scene, one or more of the signal processing modules included in the image signal processing block **108** may be shut down without affecting the desired optical mouse function. For example, the pre-processing module **212**, the white balance module **214** and/or the post-processing module **220** may be disabled when the multi-purpose camera system **102** is operated in the second operation mode, such that the input of the disabled signal processing module is bypassed without being processed by the disabled signal processing module. Additionally, due to shutting down one or more signal processing modules in the second operation mode, power consumption of the image signal processing block **108** in the second operation mode is lower than power consumption of the image signal processing block **108** in the first operation mode. In a case where the electronic device **100** is a portable electronic device powered by a battery device, the electronic device **100** may benefit from such a low power consumption feature of the multi-purpose camera system **102** when the multi-purpose camera system **102** is configured to act as part of an optical mouse which is required to continuously capture successive images for detecting movement/action of an object such as user's finger.

In a second exemplary design, at least one signal processing module included in the image signal processing block **108** employs a first algorithm in the first operation mode, and employs a second algorithm different from the first algorithm in the second operation mode. As the multi-purpose camera system **102** operated in the second operation mode to perform an optical mouse function does not need to produce a precise image of a captured scene, one or more of the signal processing modules included in the image signal processing block **108** may employ the second algorithm (e.g., a simplified algorithm or a low-power algorithm) without affecting the desired optical mouse function. Hence, images which can be used to successfully detect the movement/action of the object (e.g., user's finger) may be obtained by configuring the demosaic module **216** to use a simplest algorithm among all available demosaicing algorithms, and/or configuring the color transform module **218** to perform an RGB-to-YUV color transform upon a color image to generate a black & white image and only store luminance (Y) values derived from the RGB-to-YUV color transform.

After a luminance image (i.e., black & white image) is obtained by the color transform module **218**, the following post-processing module **220** may derive a binary image from the black & white image by comparing a luminance value of each pixel in the black & white image with a threshold value, assigning a first predetermined luminance value (e.g., 255) to the pixel when the luminance value is greater than the threshold value, and assigning a second predetermined luminance value (e.g., 0) to the pixel when the luminance value is not greater than the threshold value. Thus, as the computational complexity is reduced due to image binarization, the optical

mouse function can be easily realized through analyzing successive binary images by using the simplified algorithm/low-power algorithm.

Alternatively, after a luminance image (i.e., black & white image) is obtained by the color transform module **218**, the following post-processing module **220** may down-sample the black & white image with an original image resolution (e.g., 720×480) to generate a down-sampled black & white image with a reduced image resolution (e.g., 45×30), and then derive a binary image from the down-sampled black & white image by comparing a luminance value of each pixel in the down-sampled black & white image with a threshold value, assigning a first predetermined luminance value (e.g., 255) to the pixel when the luminance value is greater than the threshold value, and assigning a second predetermined luminance value (e.g., 0) to the pixel when the luminance value is not greater than the threshold value. Thus, as the computational complexity may be significantly reduced by image binarization and down-sampling, the optical mouse function can be easily realized through analyzing successive down-sampled binary images by using simplified algorithm/low-power algorithm.

Additionally, due to using simplified algorithm/low-power algorithm in the second operation mode, power consumption of the image signal processing block **108** in the second operation mode is lower than power consumption of the image signal processing block **108** in the first operation mode. In a case where the electronic device **100** is a portable electronic device powered by a battery device, the electronic device **100** may benefit from such a low power consumption feature of the multi-purpose camera system **102** when the multi-purpose camera system **102** is configured to act as part of an optical mouse which is required to continuously capture successive images for detecting movement/action of an object such as user's finger.

In a third exemplary design, at least one control module included in the control circuit **116** employs a first algorithm in the first operation mode, and employs a second algorithm different from the first algorithm in the second operation mode. As the multi-purpose camera system **102** operated in the second operation mode to perform an optical mouse function does not need to produce a precise image of a captured scene, one or more of the control modules included in the control circuit **116** may employ the second algorithm (e.g., a simplified algorithm or a low-power algorithm) without affecting the desired optical mouse function. More specifically, the object (e.g., user's finger) to be detected in the second operation mode is generally placed just in front of the camera lens of the optical system **112**. Hence, images which can be used to successfully detect the movement/action of the object (e.g., user's finger) may be obtained by setting the exposure control module **204** to use a pre-defined and fixed exposure parameter setting instead of a normal auto-exposure function, and/or setting the focus control module **202** to use a pre-defined and fixed focus parameter setting instead of a normal auto-focus function. Additionally, due to using simplified algorithm/low-power algorithm in the second operation mode, power consumption of the control circuit **116** in the second operation mode is lower than power consumption of the control circuit **116** in the first operation mode. In a case where the electronic device **100** is a portable electronic device powered by a battery device, the electronic device **100** may benefit from such a low power consumption feature of the multi-purpose camera system **102** when the multi-purpose camera system **102** is configured to act as part of an optical mouse which is required to continuously capture successive images for detecting movement/action of an object such as user's finger.

In a fourth exemplary design, the image capture block **106** is configured to operate in a first capture frame rate in the first operation mode, and is configured to operate in a second capture frame rate higher than the first capture frame rate in the second operation mode. For example, the first capture frame rate is set by a normal frame rate of a camera, and the second capture frame rate is set by a highest frame rate supported by the multi-purpose camera system **102**. With an increased capture frame rate employed by the multi-purpose camera system **102** in the second operation mode, the sensitivity of the optical mouse function is improved accordingly.

In a fifth exemplary design, the image capture block **106** is configured to operate in a first capture resolution in the first operation mode, and is configured to operate in a second capture resolution lower than the first capture resolution in the second operation mode. As the multi-purpose camera system **102** operated in the second operation mode to perform an optical mouse function does not need to produce a precise image of a captured scene, the capture resolution may be reduced in the second operation mode to reduce the computational complexity as well as power consumption. Similarly, in a case where the electronic device **100** is a portable electronic device powered by a battery device, the electronic device **100** may benefit from such a low power consumption feature of the multi-purpose camera system **102** when the multi-purpose camera system **102** is configured to act as part of an optical mouse which is required to continuously capture successive images for detecting movement/action of an object such as user's finger.

As mentioned above, the multi-purpose camera system **102** supports different operation modes, including the first operation mode (e.g., normal camera mode) and the second operation mode (e.g., optical mouse mode). The multi-purpose camera system **102** may switch between different operation modes in response to a mode control signal triggered by the user or application software. FIG. **3** is a flowchart illustrating a mode switching operation of the multi-purpose camera system **102** according to an exemplary embodiment. Provided that the result is substantially the same, the steps are not required to be executed in the exact order shown in FIG. **3**. The exemplary mode switching operation may be briefly summarized as follows.

Step **300**: Start.

Step **302**: Check which operation mode that the multi-purpose camera system **102** should enter. If the multi-purpose camera system **102** is required to enter the first operation mode (e.g., normal camera mode), the flow proceeds with step **304**. If the multi-purpose camera system **102** is required to enter the second operation mode (e.g., optical mouse mode), the flow proceeds with step **310**.

Step **304**: Set the normal capture frame rate for the normal camera mode.

Step **306**: Enable control modules of the control circuit **116** and signal processing modules of the image signal processing block **108** in the normal camera mode.

Step **308**: Perform the normal camera process to generate the captured image output IMG_OUT**1**. Next, the flow proceeds with step **302** to check if the current operation mode should be changed.

Step **310**: Set the higher capture frame rate for the optical mouse mode.

Step **312**: Shut down at least one module of the control circuit **116** and the image signal processing block **108**, and/or control at least one module of the control circuit **116** and the image signal processing block **108** to employ a simplified algorithm or a low-power algorithm.

Step **314**: Perform the optical mouse process to generate the image output IMG_OUT**2**. Next, the flow proceeds with step **302** to check if the current operation mode should be changed.

As a person skilled in the art can readily understand details of each step in FIG. **3** after reading above paragraphs, further description is omitted here for brevity.

After the image output IMG_OUT**2** is generated from the multi-purpose camera system **102**, the image output IMG_OUT**2** may be further processed to identify the user input, such as movement/action of user's finger. For example, the user input processing system **104** shown in FIG. **1** may identify the user input as one of a plurality of predetermined mouse operations, including a single click action, a double click action, a fast/slow cursor move action, etc. When an image frame of the image output IMG_OUT**2** indicates that there is no object (e.g., user's finger) present, an "All White" status is detected by the user input processing system **104**. When an image of the image output IMG_OUT**2** indicates that there is an object (e.g., user's finger) present and the covered image area percentage of the object (e.g., user's finger) in the checked image frame exceeds a threshold value, an "All Black" status is detected by the user input processing system **104**. Hence, in a case where the user input processing system **104** sequentially detects "All White" status, "All Black" status and "All White" status when processing three consecutive image frames of the image output IMG_OUT**2**, the user input processing system **104** therefore identifies the user input as a single click action. In another case where the user input processing system **104** sequentially detects "All White" status, "All Black" status, "All White" status and "All Black" status when processing four consecutive image frames of the image output IMG_OUT**2**, the user input processing system **104** therefore identifies the user input as a double click action.

Besides, the user input processing system **104** may obtain coordinate information of the object (e.g., user's finger) by processing image frames of the image output IMG_OUT**2**. For example, the user input processing system **104** may perform the global motion estimation operation upon the image frames of the image output IMG_OUT**2** to identify coordinates of the object (e.g., user's finger) found in the image frames. Please refer to FIG. **4**, which is a diagram illustrating an exemplary implementation of the user input processing system **104** shown in FIG. **1**. The user input processing system **104** includes a global motion estimation block **402** and a processor **404**. The global motion estimation block **402** is arranged for generating global motion information INF according to the image output IMG_OUT**2** of the image signal processing block **108**. The processor **404** is arranged for identifying the user input according to the global motion information INF. When none of the aforementioned "All White" state and "All Black" status can be detected in the consecutive image frames each having the covered image area percentage of the object (e.g., user's finger) not exceeding the threshold value, the processor **404** may calculate the coordinate change rate of consecutive image frames of the image output IMG_OUT**2** to determine if the user input is a fast cursor move action or a slow cursor move action.

The global motion estimation block **402** may be a functional block dedicated to processing the image output IMG_OUT**2** generated in the second operation mode. However, this is for illustrative purposes only, and is not meant to be a limitation of the present invention. Alternatively, if the camera system is equipped with an electronic image stabilization (EIS) module, the EIS module may also be used as the global motion estimation block **402** due to the fact that the EIS module is capable of performing the desired global motion estimation. That is, the EIS module performs its designated EIS function when the multi-purpose camera system **102** is operated in the first operation mode (e.g., normal camera mode), and acts as the global motion estimation block **402** when the multi-purpose camera system **102** is operated in the second operation mode (e.g., optical mouse mode).

Similarly, the processor **404** may be a functional block dedicated to processing the global motion information INF derived from the image output IMG_OUT**2** to identify the user input as a fast cursor move action or a slow cursor move action, or processing image frames of the image output IMG_OUT**2** to identify the user input as a single click action or a double click action. However, this is for illustrative purposes only, and is not meant to be a limitation of the present invention. In an alternative design, a central processing unit (CPU) of the electronic device **100** may also be used to act as the processor **404**.

FIG. **5** is a flowchart illustrating an exemplary user input identification operation performed by the user input processing system **104** to identify the user input as one optical mouse operation. Provided that the result is substantially the same, the steps are not required to be executed in the exact order shown in FIG. **5**. The exemplary user input identification operation may be briefly summarized as follows.

Step **500**: Start.

Step **502**: Receive an image of the image output IMG_OUT**2** generated from the image signal processing block **108** in the second operation mode.

Step **504**: Check if the received image frame of the image output IMG_OUT**2** has an object (e.g., a dark image area representative of user's finger) present. If yes, go to step **508**; otherwise, go to step **506**:

Step **506**: Send an "All White" status. Next, the flow proceeds with step **502** to receive the next image of the image output IMG_OUT**2**.

Step **508**: Check if the covered image area percentage of the object exceeds a threshold value. If yes, go to step **510**; otherwise, go to step **512**.

Step **510**: Send an "All Black" status. Next, the flow proceeds with step **502** to receive the next image of the image output IMG_OUT**2**.

Step **512**: Perform global motion estimation upon adjacent images to derive the global motion information INF.

Step **514**: According to the global motion information INF, calculate the optical mouse coordinate. Next, the flow proceeds with step **502** to receive the next image of the image output IMG_OUT**2**.

Based on the status transition pattern (e.g., a sequence of "All White", "All Black" and "All White", or a sequence of "All White", "All Black", "All White" and "All Black") or the optical mouse coordinates, the processor **404** is capable of identifying the user input as one optical mouse operation. As a person skilled in the art can readily understand details of each step in FIG. **5** after reading above paragraphs, further description is omitted here for brevity.

Please note that proposed multi-purpose camera system **102** of the present invention is not limited to the optical mouse application. In one alternative design, the user input processing system **104** shown in FIG. **1** may identify the user input as one of a plurality of predetermined directional key operations, including an up key pressing action, a down key pressing action, a left key pressing action, and a right key pressing action. For example, the processor **404** may compare coordinates of the object (e.g., user's finger) in different image frames to determine which directional key operation is entered by the user. In another alternative design, the user

input processing system **104** shown in FIG. **1** may identify the user input as one of a plurality of predetermined touch panel operations. To put it simply, the user input apparatus composed of the multi-purpose camera system **102** and the user input processing system **104** operated in the second operation mode may act as an optical mouse, directional keys/directional pad or a touch panel, depending upon actual design requirement/consideration.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A multi-purpose camera system, comprising:

an image capture block, arranged for generating an image signal, wherein the image capture block comprises an image sensor, an optical system, and a control circuit; and

an image signal processing block, arranged for processing the image signal;

wherein when the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input; an overall configuration of the control circuit and the image signal processing block in the first operation mode is different from an overall configuration of the control circuit and the image signal processing block in the second operation mode; and at least one of the image signal processing block and the control circuit has lower power consumption in the second operation mode than in the first operation mode.

2. The multi-purpose camera system of claim **1**, wherein power consumption of the image signal processing block in the second operation mode is lower than power consumption of the image signal processing block in the first operation mode.

3. The multi-purpose camera system of claim **1**, wherein one signal processing module included in the image signal processing block is enabled in the first operation mode, and is disabled in the second operation mode.

4. The multi-purpose camera system of claim **1**, wherein one signal processing module included in the image signal processing block employs a first algorithm in the first operation mode, and employs a second algorithm different from the first algorithm in the second operation mode.

5. The multi-purpose camera system of claim **1**, wherein power consumption of the control circuit in the second operation mode is lower than power consumption of the control circuit in the first operation mode.

6. The multi-purpose camera system of claim **1**, wherein one control module included in the control circuit employs a first algorithm in the first operation mode, and employs a second algorithm different from the first algorithm in the second operation mode.

7. The multi-purpose camera system of claim **1**, wherein when the multi-purpose camera system acts as part of the user input apparatus, the control circuit employs a pre-defined and fixed focus parameter setting.

8. The multi-purpose camera system of claim **1**, wherein when the multi-purpose camera system acts as part of the user input apparatus, the control circuit employs a pre-defined and fixed exposure parameter setting.

9. The multi-purpose camera system of claim **1**, wherein the image signal processing block converts a color image into a black & white image in the second operation mode.

10. The multi-purpose camera system of claim **9**, wherein the image signal processing block performs an RGB-to-YUV color transform upon the color image, and only stores luminance values derived from the RGB-to-YUV color transform.

11. A multi-purpose camera system, comprising:

an image capture block, arranged for generating an image signal, wherein the image capture block comprises an image sensor, an optical system, and a control circuit; and

an image signal processing block, arranged for processing the image signal;

wherein when the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input; an overall configuration of the control circuit and the image signal processing block in the first operation mode is different from an overall configuration of the control circuit and the image signal processing block in the second operation mode; the image signal processing block converts a color image into a black & white image in the second operation mode; the image signal processing block further compares a luminance value of a pixel in the black & white image with a threshold value; when the luminance value is greater than the threshold value, the image signal processing block assigns a first predetermined luminance value to the pixel; and when the luminance value is not greater than the threshold value, the image signal processing block assigns a second predetermined luminance value to the pixel.

12. A multi-purpose camera system, comprising:

an image capture block, arranged for generating an image signal, wherein the image capture block comprises an image sensor, an optical system, and a control circuit; and

an image signal processing block, arranged for processing the image signal;

wherein when the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input; and an overall configuration of the control circuit and the image signal processing block in the first operation mode is different from an overall configuration of the control circuit and the image signal processing block in the second operation mode; the image signal processing block converts a color image into a black & white image in the second operation mode; the image signal processing block further down-samples black & white image to generate a down-sampled black & white image, and compares a luminance value of a pixel in the down-sampled black & white image with a threshold value; when the luminance value is greater than the threshold value, the image signal processing block assigns a first predetermined luminance value to the pixel; and when the luminance value is not greater than the threshold value, the image signal processing block assigns a second predetermined luminance value to the pixel.

13. The multi-purpose camera system of claim 1, wherein a white balance module included in the image signal processing block is enabled in the first operation mode, and is disabled in the second operation mode.

14. The multi-purpose camera system of claim 1, wherein the image capture block operates at a first capture frame rate in the first operation mode, and operates at a second capture frame rate higher than the first capture frame rate in the second operation mode.

15. The multi-purpose camera system of claim 1, wherein the image capture block operates at a first capture resolution in the first operation mode, and operates at a second capture resolution lower than the first capture resolution in the second operation mode.

16. An electronic device, comprising:

a multi-purpose camera system, comprising:

an image capture block, arranged for generating an image signal, wherein the image capture block comprises an image sensor, an optical system, and a control circuit; and

an image signal processing block, arranged for processing the image signal, wherein when the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input; an overall configuration of the control circuit and the image signal processing block in the first operation mode is different from an overall configuration of the control circuit and the image signal processing block in the second operation mode; and at least one of the image signal processing block and the control circuit has lower power consumption in the second operation mode than in the first operation mode; and

a user input processing system, acting as another part of the user input apparatus and arranged for identifying the user input by processing an image output of the image signal processing block in the second operation mode.

17. The electronic device of claim 16, wherein the user input processing system comprises:

a global motion estimation block, arranged for generating global motion information according to the image output of the image signal processing block; and

a processor, arranged for identifying the user input according to the global motion information.

18. The electronic device of claim 17, wherein the global motion estimation block is an electronic image stabilization (EIS) module.

19. The electronic device of claim 16, wherein the user input processing system identifies the user input as one of a plurality of predetermined mouse operations.

20. The electronic device of claim 16, wherein the user input processing system identifies the user input as one of a plurality of predetermined directional key operations.

21. The electronic device of claim 16, wherein the user input processing system identifies the user input as one of a plurality of predetermined touch panel operations.

22. The electronic device of claim 16, being a portable electronic device.

23. The electronic device of claim 22, wherein the portable electronic device is a mobile phone.

24. A multi-purpose camera system integrated in a portable electronic device, comprising:

an image capture block, arranged for generating an image signal; and

an image signal processing block, arranged for processing the image signal;

wherein when the multi-purpose camera system is operated in a first operation mode, the multi-purpose camera system acts as a camera for generating a captured image output; when the multi-purpose camera system is operated in a second operation mode, the multi-purpose camera system acts as part of a user input apparatus for receiving a user input; and a control circuit included in the image capture block has lower power consumption in the second operation mode than in the first operation mode.

25. The multi-purpose camera system of claim 24, wherein the portable electronic device is a mobile phone.

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